Division of Agricultural Sciences
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COST AND FACTOR PRICE CHANGES IN THE VEGETABLE PRODUCING AND PROCESSING INDUSTRIES, 1947-1959

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CALIFORNIA AGRICULTURAL EXPERIMENT STATION
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FOREWORD

This is the sixth in a series of reports dealing with the competitive position of the Western Region in marketing frozen fruits and vegetables. The present study focuses on recent relative changes in factor prices and costs in the vegetable producing and processing industries, both regionally and nationally. Such changes may significantly affect the nature of supply response to price changes and alter the comparative advantage among regions.

This study is part of work being carried on by the California Agricultural Experiment Station under western regional marketing research, Project Number WM-17, in cooperation with the Experiment Stations of Oregon, Washington, and Hawaii, and with the Agricultural Marketing Service of the U. S. Department of Agriculture.

In preparing the report, valuable comments and suggestions were provided by D. D. Caton, I. M. Lee, and L. L. Sammet.

PREVIOUS PUBLICATIONS IN THIS SERIES BY THE GIANNINI FOUNDATION, UNIVERSITY OF CALIFORNIA, CONCERNING INTERREGIONAL COMPETITION IN FROZEN FRUITS AND VEGETABLES

Reed, Robert H., Survey of the Pacific Coast Frozen Fruit and Vegetable Industry, Mimeographed Report No. 198, September, 1957.

Dennis, C. C., An Analysis of Costs of Processing Strawberries for Freezing, Mimeographed Report No. 210, July, 1958.

Dennis, C. C., The Location and Cost of Strawberry Production, Mimeographed Report No. 217, March, 1959.

Reed, Robert H., Economic Efficiency in Assembly and Processing Lima Beans for Freezing, Mimeographed Report No. 219, June, 1959.

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COST AND FACTOR PRICE CHANGES IN THE VEGETABLE PRODUCING AND PROCESSING INDUSTRIES, 1947-1959

by

Ben C. French[1/]

INTRODUCTION

Since World War II the vegetable producing and processing industries, like most industries, have been continuously influenced by both cost increasing and cost decreasing forces. Prices of labor, materials, equipment, and other inputs have risen substantially. In some instances the quality and service attached to the final product have also increased. Simultaneously, new techniques and improved organization have led to rising levels of productive efficiency.

Although indicators of relative change in prices of many input components are readily available, little has been done to measure the net impact of these economic forces on costs of producing and processing vegetables, either nationally or regionally. This report develops such measures and also presents data which provide some insight into the nature of change in farm and processed vegetable production relative to the input of resources. The data presented were computed originally for use in analysing supply response to product price and cost changes. However, they are of interest in themselves insofar as they reveal something of the nature of the relationship among costs, factor prices, and productivity, and account for some of the economic changes occurring in these industries.

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Changes are expressed in relative terms--as index numbers--rather than absolute values. Indexes dealing with vegetable production have been computed for each major vegetable producing region and for the entire United States.[1/] Data pertaining to processing are available only on a national basis.[2/] Farm production data refer to both vegetables for processing and fresh market, but with primary emphasis on processing vegetables.

Production and processing inputs have each been grouped into three major classes, determined by their relative importance and the availability of representative data. Production cost components are (1) labor, (2) land, and (3) other production inputs (repairs, fuel, materials, depreciation of equipment and buildings, etc.). Processing cost components are (1) labor, (2) packaging materials, and (3) capital and overhead (rent, depreciation, repairs, interest, property taxes, etc.).[3/] Selling costs and costs of the

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1/ Regions and states included are: Northeast--Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland. Lake States--Michigan, Wisconsin, Minnesota. Corn Belt--Ohio, Indiana, Illinois, Iowa, Missouri. Pacific--Washington, Oregon, California.

2/ Data pertaining exclusively to factor prices and costs in vegetable processing are not available. The data presented refer to the food processing or canning and preserving industry as a whole. Since the vegetable industry is contained within the larger industry and is subject to similar economic forces, relative price changes seem likely to correspond closely.

3/ Land cost is a relatively minor part of processing cost and is therefore included in capital and overhead rather than listing it as a separate category. Packaging materials, minor in farm production costs, are included in other production inputs at the farm level but are classed separately in processing because of their greater importance in this operation.

raw vegetable product are not included. With these exceptions, the three classes include nearly all important types of production and processing inputs. Index numbers were computed for each input class from published data which provide the best available representation of average price, cost, and output changes. Indexes of change in prices and costs of all inputs combined were computed by averaging the component indexes, weighted by the relative importance of each component in total cost. Details of the methods and data used to construct these indicators, together with their limitations, are described in Appendix A.

CHANGES IN PRICES OF FACTORS USED TO PRODUCE AND PROCESS VEGETABLES

Farm Production

Relative 1947 to 1959 changes in United States average prices paid for the major classes of inputs used in farm vegetable production are illustrated in Figure 1. The index numbers indicate that since 1947-49 land prices have increased more rapidly than labor prices (wage rates) and labor prices have, in turn, increased more rapidly than prices of "other production inputs."

Regional variations are given in Table 1. The Pacific region shows the lowest percentage increase in prices of all factors combined (column 14), reflecting the lower percentage increase in wage rates in that area (column 4). Note, however, that this does not mean that actual wage rates are lower in the Pacific region; they are, in fact, substantially higher--see Appendix Table 3. Actual wage rates have increased by about the same absolute amount in all regions, leading to a greater percentage increase in regions with lower wage levels.

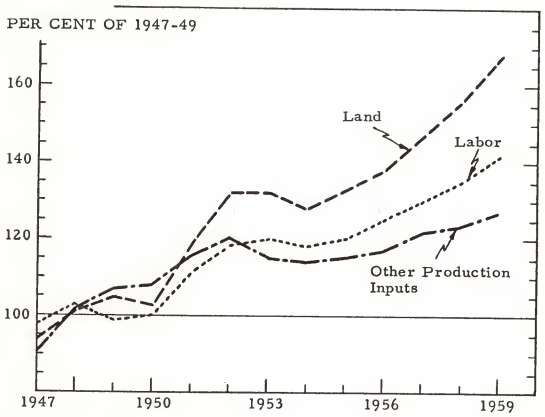

Figure 1. Changes in prices of major inputs used in farm vegetable production, United States, 1947 to 1959.

TABLE 1

Relative Changes in Prices Paid for Factors Used in Producing Vegetables, by United States Regions, 1947-1959

Year	Labor[a]				Land[b]					Other production inputs[c]	All factors[d]				
	North East	Lake States & Corn Belt[e]	Pacific	United States	North East	Lake States	Corn Belt	Pacific	United States	United States	North East	Lake States	Corn Belt	Pacific	United States
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1947-49 = 100														
1947	98	95	99	98	95	94	94	100	94	91	94	93	93	96	94
1948	103	104	104	103	99	101	101	102	101	102	102	103	103	103	102
1949	99	101	97	99	105	105	105	98	105	107	103	104	104	101	103
1950	100	102	97	100	102	104	106	96	103	108	104	105	105	101	104
1951	111	115	106	111	110	119	125	110	119	115	113	116	116	110	114
1952	118	123	111	118	121	127	135	123	132	120	119	122	124	116	121
1953	122	127	114	120	122	127	134	127	132	115	119	122	123	116	120
1954	122	125	113	118	121	122	132	124	128	114	118	120	122	115	118
1955	124	128	115	120	123	127	139	130	133	115	120	122	124	117	120
1956	130	133	120	125	130	135	144	137	138	117	124	127	128	121	124
1957	135	137	122	130	139	147	154	146	147	122	130	132	133	126	129
1958	138	137	124	135	147	154	162	156	156	124	133	134	135	129	134
1959	140	141	127	142	158	165	173	168	168	126	137	138	139	133	139

a/ Composite farm wage rate per hour. Wage rates for 1947 were computed by multiplying the ratio of 1947 to 1948 composite rates (old series) by the 1948 rate (new series).

b/ Indexes based on average value per acre of farm real estate as of March 1.

c/ U. S. Department of Agriculture index of prices paid by farmers for items used in production, excluding feed and livestock. The index is computed on a national basis only and includes motor supplies, motor vehicles, farm machinery, farm supplies, building and fencing materials, fertilizer, and seed.

(Continued on next page)

TABLE 1 (continued)

d/ Computed from columns 1-10 using the following weights: Labor, .41; land, .15; production inputs, .44. (See Appendix A for details of weight selection).

e/ Farm wage rates are reported on a slightly different geographic basis than land values and the other series used in this report. The index of wage rates for the Middle Atlantic region has been used to represent the North East and the index of wage rates for the East North Central region has been used to represent both the Lake States and Corn Belt. States included are, Middle Atlantic: New York, New Jersey, Pennsylvania; East North Central: Ohio, Indiana, Illinois, Michigan, Wisconsin.

Source:

Labor

U. S. Agricultural Marketing Service, Farm Labor, (Washington, D.C., monthly), issues of January 1958, 1959, and 1960.

Land

U. S. Agricultural Research Service, Current Developments in the Farm Real Estate Market, (Washington, D.C., issued three times per year).

Other Production Expenses

U. S. Agricultural Marketing Service, Crop Reporting Board, Agricultural Prices (Washington, D.C., monthly). The index was computed excluding feed and livestock, using weights given in Supplement No. 1 to Agricultural Prices, January 1959, and converted to a 1947-49 base.

Processing

Relative changes in United States average prices paid for factors used in processing vegetables are given in Table 2. Prices of all major input components used in canning have increased at about the same rate since 1947 (columns 1, 2, and 3).[1/] Prices of packaging materials used in freezing have increased somewhat less since that time (column 4). Changes in average prices of all inputs excluding materials (column 5) and all canning inputs (column 6) have been very similar. Average prices of all factors combined have increased somewhat less for freezing than for canning due to the relatively smaller increase in costs of packaging materials for frozen vegetables.

Figure 2 compares relative changes in factor prices for farm production and processing. Since 1947-49, prices of inputs used in canning vegetables have increased by about 54 percent compared to 46 percent for freezing and 39 percent for farm production. Differences in the rate of increase in average prices paid for farm and processing inputs are due in part to lower percentage increases in farm as compared to processing wage rates and to lower percentage increases in prices of "other farm production inputs." However, the latter have been offset somewhat by large increases in prices of land inputs, leading to the results illustrated in Figure 2.

1/ Increases in canning materials prices are probably slightly overstated since a small percentage of canning materials consists of paper products which have shown lesser percentage increases in price than have cans.

TABLE 2

Relative Changes in Prices Paid for Items Used in Canning and Freezing Vegetables, United States, 1947-1959

Year	Wage rates a/	Capital and overhead b/	Packaging materials		Capital, overhead, and labor	All items	
			Canning c/	Freezing d/		Canning	Freezing
	1	2	3	4	5	6	7
	1947-49 = 100						
1947	95	92	91	99	94	93	96
1948	102	101	101	102	102	101	102
1949	103	107	109	99	104	107	102
1950	109	109	109	105	109	109	107
1951	116	119	121	132	117	119	124
1952	120	122	122	127	121	121	124
1953	124	123	127	124	124	125	124
1954	129	125	131	125	128	129	126
1955	133	128	133	127	131	132	129
1956	143	138	142	135	141	142	138
1957	149	146	151	136	148	149	142
1958	152	150	156	136	151	154	144
1959e/	157	153	153	136	156	154	146

a/ Average hourly earnings of production workers or nonsupervisory employees in the Canning and Preserving industries.

b/ Bureau of Labor Statistics wholesale price index for machinery and motive parts.

c/ BLS wholesale price index for metal containers. The index is biased slightly upward since a small percentage of paper products is included in canning materials.

d/ BLS wholesale price index for paper board.

e/ Preliminary estimate.

Source:

Wage Rates:

U. S. Bureau of Labor Statistics, Monthly Labor Review, (Washington, D.C., monthly).

Wholesale Price Indexes:

U. S. Bureau of Labor Statistics, Wholesale Price Index, Indexes for Groups, Subgroups, and Product Classes of Commodities, 1947-1951, (Washington: Govt. Print. Off., February 1952) and Wholesale Price Index, Annual Summaries.

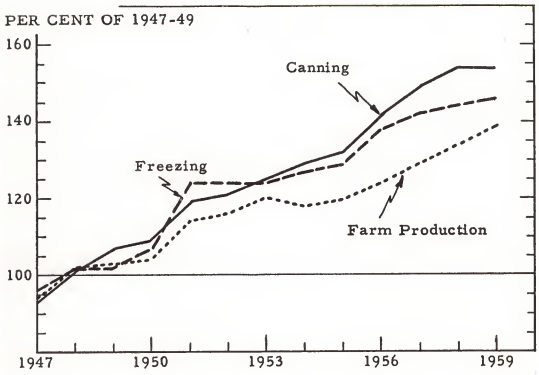

Figure 2. Changes in prices paid for factors used in producing, canning and freezing vegetables, United States, 1947 to 1959.

CHANGES IN COST PER UNIT OF OUTPUT IN PRODUCING AND PROCESSING VEGETABLES

The cost of any input per unit of output is simply the price of the input multiplied by the quantity of the input used and divided by the corresponding output of product. If input prices increase, with all quantities constant, cost per unit of product will increase by the same percentage. But if input per unit of output (or output per unit of input) also changes, cost per unit will not change in the same proportion as input price; it may be higher or lower depending on whether output per unit of input has decreased or increased.

In both the vegetable producing and processing industries substantial changes have occurred in the quantities of various inputs required per unit of output (or in output per unit of input). Dividing the index of prices paid for each input category (Tables 1 and 2) by a corresponding index of output per unit of input (Appendix Tables 7, 8, and 9) approximates the relative changes in cost per unit of output.[1/] This procedure also involves the assumption that relative changes in prices of the services of durable factors, such as land rent, will correspond closely to relative changes in prices of the factors themselves.

Farm Production Cost

Indicators of relative change in United States average cost per unit of farm vegetable output for each input category are shown graphically in

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1/ Cost per unit of output for "other farm production inputs" and "capital and overhead" for processing actually were calculated first and the indexes of output per unit of input derived from them. See footnotes to Tables 3 and 5 and Appendix A for further explanation. Processing container materials cost per unit of output is identical with materials price.

Figure 3, with regional variations given in Table 3. Labor cost per unit of output has declined during most of the period since 1947. Increases in vegetable output per unit of labor input have more than matched the increases in wage rates. Costs of the services of land increased rapidly from 1947 to 1952 and thereafter at a much slower rate. With increased yields the rate of increase in cost was somewhat less than the percentage increase in land price. Costs of "other production inputs" varied much as did land costs but in this case relative changes in cost slightly exceeded the relative changes in prices of these inputs. This means that the decreased labor and land requirements were associated with increased quantities of "other" inputs for each unit of output, attributable to such things as more intensive use of fertilizers and other yield increasing factors and increasing mechanization of operations.

Relative changes in total cost per unit of output, reflecting the combined effects of the component cost changes, are given in Table 4. The rapid increases in costs of land and "other production inputs" up to about 1952 more than offset the decreases in labor cost per unit so that total cost per unit of product rose. Since that time, reductions in unit labor costs have equalled or outweighed the smaller increases in land and other costs and total unit costs have generally declined or leveled off. As in the case of factor price changes, the Pacific region shows the lowest overall percentage (but not absolute) change in cost per unit of output. This is largely due to a smaller relative increase in wage rates in the Pacific and, in most years, a greater percentage increase in vegetable yields.

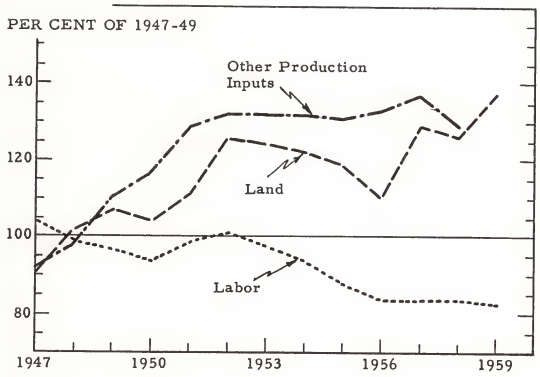


Figure 3. Change in cost per unit of output for major classes of farm vegetable production inputs, United States, 1947 to 1959.

TABLE 3

Relative Changes in Component Costs per Unit of Farm Vegetable Output by United States Regions, 1947-1959

Year	Labor[a]					Land[b]					Other Production Inputs[c] [d]				
	North East	Lake States	Corn Belt	Pacific	United States	North East	Lake States	Corn Belt	Pacific	United States	North East	Lake States	Corn Belt	Pacific	United States
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1947-49 = 100														
1947	102	106	104	105	104	100	111	111	102	91	89	92	102	89	92
1948	99	102	96	102	99	95	88	88	104	102	102	100	93	102	98
1949	99	94	100	93	97	104	101	101	94	107	109	108	106	109	110
1950	94	94	92	90	94	93	98	100	97	104	108	117	115	112	117
1951	105	99	105	98	99	99	111	117	93	111	119	124	131	122	129
1952	107	104	115	97	101	115	119	126	103	126	125	125	130	125	132
1953	103	103	110	92	98	109	115	122	108	124	121	127	135	126	132
1954	102	98	104	86	94	116	109	118	108	123	121	125	132	122	132
1955	92	88	97	83	88	114	114	125	105	119	123	125	130	126	131
1956	89	85	94	83	84	106	105	111	102	110	122	126	127	126	133
1957	91	93	93	78	84	129	128	134	119	129	133	133	134	125	137
1958	88	77	86	78	84	122	123	130	116	126	125	130	126	129	129
1959	90	74	82	75	83	142	120	126	130	137	---	---	---	---	---

a/ Computed by dividing each index of farm wage rates (Table 1) by the corresponding index of farm vegetable production per man-hour (Appendix Table 7).

b/ Computed by dividing each index of land values (Table 1) by the corresponding index of yields of fresh and processed vegetables combined (Appendix Table 8). The computed series for the Lake States and Corn Belt involve a slight adjustment so that 1947-49 = 100.

c/ Includes current farm operating expenses and depreciation and other capital consumption.

d/ Computed by dividing an index of total cost of "other production inputs" by the Agricultural Research Service index of gross farm output. See Appendix Tables 4 and 5. Data for 1959 were not available at the time this was written.

TABLE 4

Relative Changes in Total Cost per Unit of Farm Vegetable Output, by United States Regions, 1947-1959

Year	North East	Lake States	Corn Belt	Pacific	United States
	1	2	3	4	5
	1947-49 = 100				
1947	96	101	104	98	97
1948	100	99	93	102	99
1949	104	103	103	100	104
1950	100	105	103	101	106
1951	110	112	118	108	114
1952	116	115	123	110	118
1953	112	115	123	109	117
1954	112	112	118	105	115
1955	109	108	116	105	112
1956	106	106	111	105	109
1957	115	116	117	105	114
1958	109	107	110	106	110
1959[a/]					

a/ Not available when this was written.

Source:

Computed from Table 4, using the following weights: Labor, .41; land, .15; production inputs, .44.

Processing Cost

Relative changes in United States average cost per unit of output in vegetable processing are given in Table 5. As in the case of farm production, labor cost per unit of output has declined while costs of capital, overhead, and materials have increased. This does not mean, of course, that the efficiency of labor per se has increased while that of capital has declined. Although individual worker performance conceivably may have improved, most of the labor cost reduction seems likely to have stemmed from technological advances, capital substitution, or both. Difficulties in measuring efficiency are discussed in the next section.

Costs of non-labor processing inputs have not shown quite as great a tendency to level off since 1952 as have the comparable categories of farm production cost shown in Figure 3. The over-all effect--illustrated in Figure 4--has been that average total unit costs of production and processing increased at roughly the same general rate until about 1952 but since that time cost per unit of farm vegetable production has drifted generally downward while processing costs have continued their upward climb. However, changes in the latter have been small since 1957.

PRODUCTIVITY IN PRODUCING AND PROCESSING VEGETABLES

Productivity is the efficiency with which commodities are produced--that is, the ratio of the output of product to the input of resources. Productivity may increase with technological advances, improved organization and scale of operations and a host of less tangible factors. The changing mix of outputs and inputs and the complex nature of conditions associated with these changes make the measurement of productivity an extremely difficult and

TABLE 5

Relative Changes in Cost per Unit of Output for Inputs Used in Canning and Freezing Vegetables, United States, 1947-1959

Year	Labor a/	Capital and overhead b/	Packaging materials c/		Capital, overhead & labor	All items d/	
			Canning	Freezing		Canning	Freezing
	1	2	3	4	5	6	7
	1947-49 = 100						
1947	101	92	91	99	98	95	99
1948	102	101	101	102	102	101	102
1949	96	107	109	99	100	104	99
1950	96	111	109	105	101	105	103
1951	98	121	121	132	106	113	118
1952	97	121	122	127	105	113	115
1953	100	123	127	124	108	117	115
1954	93	126	131	125	104	117	114
1955	93	131	133	127	106	119	116
1956	94	131	142	135	106	123	120
1957	96	139	151	136	110	130	123
1958	94	146	156	136	111	133	123
1959	93	145	153	136	110	131	122

a/ Index of wage rates (Table 3) divided by index of output per production worker man-hour in the Canning and Preserving industries (Appendix Table 7).

b/ Index of capital and overhead charges in the Food and Kindred Products industries divided by the Federal Reserve Board index of output in Food Manufacturing--see columns 8 and 6, Appendix Table 6.

c/ Same as price indexes. See Table 3.

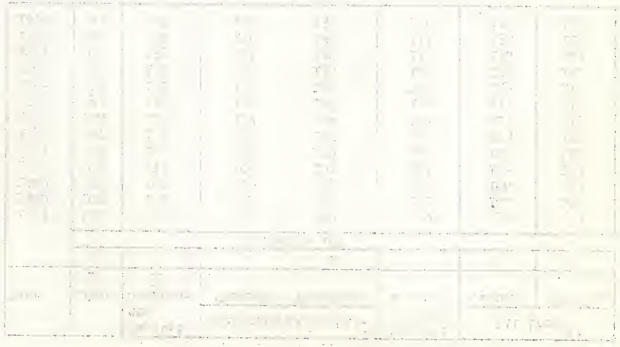
d/ Averages of columns (1), (2), and (3) or (4), using the following weights: Labor, .35; plant and equipment, .17; materials, .48.

Source:

Data on wage rates and production worker man-hours in the canning and preserving industries were obtained in U. S. Bureau of Labor Statistics, Monthly Labor Review, (Washington, D.C., monthly).

Data on costs of capital inputs in the Food and Kindred Products industries were obtained from U. S. Treasury Department, Internal Revenue Service, Statistics of Income, (Washington, D.C., annual issues). See Appendix Table 6 for details.

The index of output in Food Manufacturing is from Board of Governors of the Federal Reserve System, Federal Reserve Bulletin, (Washington, D.C., monthly).



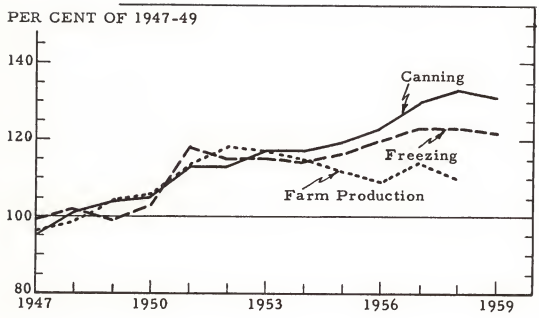


Figure 4. Changes in cost per unit of output in producing, canning, and freezing vegetables, United States, 1947 to 1959.

often questionable process. A common practice is to compute changes in output per unit of labor or some other single input (as in Appendix Tables 7, 8, and 9)[1/] but this may be misleading in that it attributes gains in output to a single input when, in fact, such increases reflect the interaction of all factors. Another and somewhat preferable procedure is to compute an index of changes in all inputs and measure changes in productivity as a ratio of change in an index of output to an index of input. As explained in Appendix A, this procedure is also subject to limitations, but for want of a better measure that is essentially the procedure used here.

The index numbers obtained by this procedure are given in Table 6. They suggest, for example, that the ratio of output to input in vegetable production was about 22 percent higher in 1958 than in 1947-49. If we argue that all gains in processing output can be attributed to combined labor, capital, and overhead inputs, with materials inputs essentially passive, output relative to these inputs increased by about 37 percent during the same period--column 6 of Table 6.[2/] However, with container materials a major input the effect of these productivity gains on cost is somewhat reduced. Changes in the ratio of output to an index of all inputs, including packaging materials, are given in columns 7 and 8.

At the farm level, differences in rates of change in output-input ratios among regions do not appear to be significant.

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1/ Also see, for example, Bright, Imogene, "Trends in Labor Input and Output in Selected Agricultural Processing Industries, 1947-1957," Agricultural Economics Research, October, 1959, and Changes in Farm Production and Efficiency, (Rev., Washington: Govt. Print. Off., July, 1960) (U. S. Department of Agriculture Stat. Bul. No. 233).

2/ The quality of packaging materials may have varied, thus indirectly influencing unit input requirements, but this is very difficult to measure. Adoption of a new type of container such as the plastic bag for frozen vegetables might well, of course, involve a substantial change in the input of package material per unit of output.

TABLE 6

Change in Output Relative to Total Inputs in Producing and Processing Vegetables, by United States Regions, 1947-1959

Year	Farm production					Processing--United States		
	North East	Lake States	Corn Belt	Pacific	United States	Capital, overhead & labor	All inputs	
							Canning	Freezing
	1	2	3	4	5	6	7	8
	1947-49 = 100							
1947	98	92	89	98	97	96	98	97
1948	102	104	111	101	103	100	100	100
1949	99	101	101	101	99	104	103	103
1950	104	100	102	100	98	108	104	104
1951	103	104	98	102	100	110	105	105
1952	103	106	101	105	103	115	107	108
1953	106	106	100	106	103	115	107	108
1954	105	107	103	110	103	123	110	111
1955	110	113	107	111	107	124	111	111
1956	117	120	115	115	114	133	115	115
1957	113	114	114	120	113	135	115	115
1958	122	125	123	122	122	137	116	117
1959[a/]						142	118	120

a/ 1959 farm production data were not available when this was written.

Source:

Computed by dividing each index of prices paid (Tables 1 and 2) by the corresponding index of cost per unit of output (Tables 4 and 5).

SUMMARY

In this report data are assembled from published sources to provide indicators of relative changes in post World War II factor prices, unit costs and productivity in the vegetable producing and processing industries. Although the estimates are by no means precise, they do provide useful rough indicators of some of the significant economic changes occurring in these industries and suggest something of the future direction of the economic forces involved.

The United States average price of inputs used in producing vegetables in 1959 was about 39 percent above the 1947-49 average. Prices of inputs used in canning were, on the average, about 54 percent above the 1947-49 average while prices of freezing inputs had increased about 46 percent. Regionally, prices of farm production inputs showed a smaller percentage increase in the Pacific region than in other major vegetable regions of the United States.

With increasing productivity average cost per unit of output increased relatively less than did prices of inputs. Unit farm production costs actually decreased from 1953 on and in 1958 were only about 10 percent above the 1947-49 average compared to a 34 percent increase in the average price paid for inputs. Similarly, canning cost per unit of output in 1959 was 31 percent above the 1947 average compared to the 54 percent increase in the prices of canning inputs. These comparisons bring out clearly the possible misleading effects of using indexes of prices paid for inputs as measures of relative change in production costs.

Measures of total "productivity" have been computed which, like nearly all such measures, are subject to important limitations. However, they at least have the virtue of taking into account the contribution of all factors

rather than attributing changes in output to a single factor, as is the case with measures of labor productivity alone. These indicators suggest that productivity--the ratio of output to input--has increased by roughly 18 to 20 percent in processing and slightly more in production since 1947-49. If all gains in processing output are attributed to labor, capital, and overhead, the productivity of these inputs appears to have increased by roughly 40 percent. The cost reducing forces--improved techniques and organization--have been more than offset by inflationary increases in input prices, but without them unit costs would have increased substantially more than has been the case.

APPENDIX A

Methods of Constructing the Indexes

Indexes of Prices Paid for Inputs.

The index of factor prices for a particular component is given by

$$(1) \qquad P_{it} = \frac{y_{it}}{y_{io}}$$

where P is the index of input prices, y is the price per unit of input, the subscript i refers to a particular component of cost, t to a particular time period and o to the base period. For example, P_{13} would be the index of wage rates (price of labor) in period 3.

Specific series used to represent each input component are described in the footnotes and source notes to Tables 1 and 3. In some instances, data pertaining exclusively to vegetable production or vegetable processing were not available and more inclusive series were substituted. For example, prices paid for "other production inputs" are represented by the U. S. Department of Agriculture index of such prices paid by all farmers (excluding feed and livestock). Prices paid for processing inputs pertain to the entire Canning and Preserving industry and in the case of "capital and overhead," to the Food and Kindred Products industry. Since the vegetable industry is contained within these industries and is subject to similar economic forces, relative price changes seem likely to correspond closely.

The composite index of average prices paid for all inputs is given by

$$(2) \quad P_t = \frac{\sum_{i=1}^{n} P_{it} z_{ik}}{\sum_{i=1}^{n} z_{1k}}$$

where z_i is the total cost of a particular input, k refers to a particular period or fixed set of weights and n is the number of input categories--three in this case.

The relative importance of each input class with respect to total cost $\left[\frac{z_{ik}}{\sum_{i=1}^{n} z_{1k}}\right]$ was determined by a review of a number of studies of costs of producing and processing vegetables.[1/] Data in the farm production cost studies suggested that vegetables could reasonably be grouped into three

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1/ Production cost data were obtained from the following reports:

Adams, R. L., Farm Management Crop Manual, (Rev. ed., Berkeley: University of California Press, 1953).

Scoville, G. P. and Staff, Market Garden Farms, 37 Years of Cost Accounts, 3 Other Farms Analyzed, (Ithaca: July, 1950) (Cornell University Agricultural Experiment Station Bulletin A.E. 744).

Gains, J. P. and A. D. Seale, Jr., Truck Crop Production Practices and Costs (State College: January, 1952) (Mississippi State Col. Agr. Expt. Sta. Circular 169).

Morrison, Earnest M., Production Costs and Returns for Canning Peas, Tomatoes, and Corn in Utah (Logan: April, 1952) (Utah Agr. Exp. Sta. Mimeo. Mimeo. Series 388, April, 1952).

California Agricultural Extension Service, "Sample Production Costs," various counties and commodities, issued by County Extension Offices.

Hedges, Trimble R., Santa Maria Valley and Adjacent Area Vegetable Farms. 1. Organization, Inputs, and Costs, (Berkeley: University of California, College of Agriculture, Agricultural Experiment Station, June, 1954) (Giannini Foundation Mimeo. Report No. 167).

(Continued next page)

classes--(1) high labor requirements (asparagus, snap beans, sweet corn), (2) moderate labor requirements (broccoli, cauliflower, Brussel sprouts, spinach), and (3) low labor requirements (lima beans, green peas). Typical values of the relative importance of the cost components for each class of vegetables are given in Appendix Table 1. There appeared to be no reason to expect nor was there any indication in the available data of substantial differences in relative importance of the cost components among regions. Computation with the weights assigned to each of the three classes of vegetables gave only slight differences in the composite indexes of prices paid for inputs. The indexes presented in the body of the report are weighted as indicated for vegetables with moderate labor requirements.

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(Footnote 1 continued from previous page)

Primary sources of processing cost data were:

Reed, Robert H., Economic Efficiency in Assembling and Processing Lima Beans for Freezing (Berkeley: University of California, College of Agriculture, Agricultural Experiment Station, June, 1959) (Giannini Foundation Mimeo. Rept. No. 219).

Collins, Edward C. and Job K. Savage, Jr., Costs of Canning Sweet Corn in Selected Plants (Washington: Govt. Print. Off., July, 1957) (USDA, Farmer Cooperative Service, Marketing Res. Rept. No. 184).

Dennis, Carleton C., An Analysis of Costs of Processing Strawberries for Freezing (Berkeley: University of California, College of Agriculture, Agricultural Experiment Station, July, 1958) (Giannini Foundation Mimeo. Rept. No. 210).

Data in these studies were checked for consistency against estimates of the importance of these components in other types of processing operations.

APPENDIX TABLE 1

Typical Values of Relative Magnitudes of Major Production Cost Components for Three Classes of Vegetables for Processing

Cost component	High labor requirements	Moderate labor requirements	Low labor requirements
	1	2	3
	percent of total cost		
Labor	60	41	28
Land[a/]	15	15	25
Other production inputs	25	44	47
	100	100	100

a/ The estimated relative importance of land in total cost is based on reported rental values of vegetable land in the cost studies cited.

The relative cost importance of each processing input varies somewhat depending on the operating conditions facing individual firms. The range of variation and typical proportions of cost represented by each component in the studies reviewed are given in Appendix Table 2.

APPENDIX TABLE 2

Relative Magnitudes of Major Components of Vegetable Processing Costs

Component	Observed range	Typical value
	1	2
	percent of total cost	
Labor	30-40	35
Materials	40-55	48
Capital and overhead	10-20	17

Indexes of Cost per Unit of Output.

The index of cost per unit of output for a particular input is given by

$$(3) \quad \bar{C}_{it} = \frac{\bar{z}_{it}}{\bar{z}_{io}} = \frac{y_{it} x_{it}}{q_t} \div \frac{y_{io} x_{io}}{q_o} = P_{it} \frac{\bar{q}_{io}}{\bar{q}_{it}} = \frac{P_{it}}{\bar{Q}_{it}}$$

where $\bar{C}$ is an index of cost per unit of output, $\bar{z}$ is actual cost per unit of output, y is price per unit of input, x is the quantity of input, q is total quantity of product, $\bar{q}$ is quantity of product per unit of input, P is an index of input price, $\bar{Q}$ is an index of output per unit of input and the subscripts are as defined previously.

Alternately, each component cost index may be calculated by

$$(4) \quad \bar{C}_{it} = \frac{\bar{z}_{it}}{\bar{z}_{io}} = \frac{z_{it}}{z_{io}} \div \frac{q_t}{q_o} = \frac{C_{it}}{Q_t}$$

where C_{it} is an index of total cost and Q_t is an index of total output. Indexes of labor and land cost per unit of output in farm production and labor and packaging materials in processing were calculated using equation (3). Indexes of cost per unit of output for "other production inputs" and "capital and overhead" were constructed by equation (4), the procedures being determined largely by the form in which basic data were available.

The series used to construct index numbers of change in output per unit of each input (the $\bar{Q}_{it}$) are described in the footnotes and source notes to Appendix Tables 6, 7, and 8. The series used to construct indexes of total cost of "other production inputs" and "capital and overhead" (C_{it}) are described in Appendix Tables 4 and 6. Farm output indexes and indexes of output in food processing are described in Appendix Tables 5 and 6. As in the case of input prices, in some instances data pertaining exclusively to vegetables were not available and the nearest alternative series was substituted.

Relative change in total cost per unit of output may be measured by averaging the component cost indexes, weighted by the percent of total cost represented by each component in the base period. That is,

$$(5) \quad \bar{C}_t = \frac{\sum_{i=1}^{n} \bar{z}_{it}}{\sum_{i=1}^{n} \bar{z}_{io}} = \frac{\sum_{i=1}^{n} \bar{C}_{it} \bar{z}_{io}}{\sum_{i=1}^{n} \bar{z}_{io}}$$

Data that precisely indicate the relative importance of each input class in the base period are not available. Weights actually used were the typical values of relative input proportions derived from published cost studies that were used in constructing the index numbers of prices paid. Since these weights do not necessarily correspond to the base period weights the computed indexes may be biased upward or downward.

To estimate the possible magnitude of the bias the indexes were recomputed using a variety of weights, including the weights that would have been expected in the base period if the weights actually used represented the relative cost importance of each input in the most recent year (1958 or 1959).[1/] These computations suggested that over the period considered the possible error due to weighting the indexes by relative input importance for a period other than the base period would not exceed five index points, and would probably be considerably less. A slightly larger error might be involved in using these indexes to represent specific vegetables with input proportions that differ substantially from those used here.

1/ If the percent of total cost represented by each input in a current year is known or assumed, the corresponding expected percentage importance in the base period can be calculated from the component indexes of change in cost per unit of output.

Indexes of Output-Input Ratios.

Economic progress or "productivity" is commonly defined in terms of changes in output per unit of total input stemming from shifts toward equilibrium combinations of resources, adoption of improved techniques or technology or changes in the scale of operations. This is a most difficult thing to measure and to interpret since changes in both the mixture and quantity of products and inputs may be involved.

A common procedure is to construct an index of output, an index of input, and to measure changes in output per unit of input as a ratio of the two indexes. Unfortunately, it has been shown that these indicators may be biased.1/ If base period prices are used as weights the index of inputs will be biased upward and if current year prices are used as weights it will be biased downward. Ruttan has shown that under rather restricted conditions indexes based on beginning period and end period weights effectively "bracket" the range within which the "correct" measure of economic progress must fall.2/ It seems doubtful, however, that these conditions can be assumed to hold.

In spite of the rather formidable problems encountered, measures of change in output relative to the input of resources have been constructed for the vegetable producing and processing industries. They seem preferable as

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1/ See, for example, Ladd, George W., "Biases in Certain Production Indexes," Journal of Farm Economics, vol. 39, no. 1, February, 1957, pp. 75-85, and Ruttan, Vernon W., Technological Progress in the Meat Packing Industry, 1919-47 (Washington: Govt. Print. Off., January, 1954) (U. S. Dept. of Agriculture, Marketing Research Rept. No. 59).

2/ Ruttan, ibid., and Stout, Thomas T. and Vernon W. Ruttan, "Regional Patterns of Technological Change in American Agriculture," Journal of Farm Economics, vol. 40, no. 2, May, 1958, pp. 196-207.

measures of change in productive efficiency to indexes of change in average output per unit of labor input--the only type of efficiency indicator currently available for these industries.1/

The index of change in output per unit of all inputs combined was computed by deflating the index of cost per unit of output, to remove the price level effects, and taking the reciprocal. That is,

$$(6)\quad \bar{Q}_t = \frac{P_t}{\bar{C}_t} \quad .$$

This formulation is equivalent to computing $\bar{Q}_t$ as a ratio of an index of total output to an index of input where the index of input is given by

$$(7)\quad I_t = \frac{C_t}{P_t} \quad .2/$$

1/ See Bright, op. cit., and U. S. Department of Agriculture, Changes in Farm Production and Efficiency, op. cit. Also, see Appendix Table 7.

2/ Since the depreciation component of "other production inputs" and "capital and overhead" involves charges based on historical price levels, deflation by an index of current factor prices to remove price level changes may lead to some bias. To correctly measure "real" capital consumption would require that the proportion of depreciation based on each past price level be deflated by an index of factor prices for the corresponding past period. The amount of total depreciation chargeable to particular price levels is not known. Since depreciation accounts for only about a third of "capital and overhead" and "other production inputs" and only 6 to 15 percent of total inputs, the total error involved in using only an index of current prices seems likely to be small.

Thus,

$$(8)\quad \bar{Q}_t = \frac{Q_t P_t}{C_t} = P_t \left[\frac{\frac{q_t}{q_o}}{\frac{\sum_{i=1}^{n} z_{it}}{\sum_{i=1}^{n} z_{io}}} \right] = P_t \left[\frac{\sum_{i=1}^{n} \bar{z}_{io}}{\sum_{i=1}^{n} \bar{z}_{it}} \right] = \frac{P_t}{\bar{C}_t}$$

An index of input (I_t) was also computed by a procedure equivalent to averaging relative changes in quantities of each input using the same weights as were used for the price and cost indexes. The resulting indexes of change in output-input ratios were almost the same as obtained by equation (6).

The indexes of output per unit of input were also computed using a variety of weights. The extreme weights gave a maximum difference of about 5 index points in the 1959 value of the processing index and about 9 index points in the 1958 values of the production index. Since these are extremes the actual error due to incorrect weighting is probably somewhat less.

APPENDIX B

APPENDIX TABLE 3

Composite Average Hourly Farm Wage Rates in Major Vegetable Producing Regions, 1947-1959

Year	Middle Atlantic[a]	North East Central[b]	Pacific	United States
	1	2	3	4
	dollars			
1947[c]	.609	.563	.914	.548
1948	.642	.611	.959	.580
1949	.618	.595	.897	.559
1950	.622	.602	.895	.561
1951	.694	.681	.976	.625
1952	.734	.726	1.029	.661
1953	.758	.747	1.048	.672
1954	.757	.740	1.042	.661
1955	.770	.754	1.063	.675
1956	.810	.785	1.107	.705
1957	.841	.809	1.128	.728
1958	.859	.810	1.145	.757
1959	.872	.830	1.170	.798

a/ Used to represent the Northeast region.

b/ Used to represent the Corn Belt and Lake States regions.

c/ Wage rates for 1947 were computed by multiplying the ratio of 1947 to 1948 composite rates (old series) by the 1948 rate (new series).

Source:

U. S. Agricultural Marketing Service, Farm Labor (Washington, D. C., monthly).

APPENDIX TABLE 4

Total Annual Farm Production Expenses in Major Vegetable Producing Regions, 1947-1959[a]

Year	North East	Lake States	Corn Belt	Pacific	United States	North East	Lake States	Corn Belt	Pacific	United States
	1	2	3	4	5	6	7	8	9	10
	million dollars					1947-49 = 100				
1947[b]	718.4	756.6	1,427.5	572.6	6,532	87	87	87	87	87
1948[b]	846.1	891.0	1,681.3	674.4	7,693	102	102	102	102	102
1949	922.9	971.9	1,833.8	735.6	8,391	111	111	111	111	111
1950	1,962.3	1,037.5	1,971.0	784.5	8,916	116	119	120	118	118
1951	1,060.2	1,166.8	2,235.5	908.4	10,138	128	134	136	137	134
1952	1,113.0	1,218.7	2,407.4	960.1	10,772	134	140	146	145	143
1953	1,101.7	1,240.5	2,415.5	986.5	10,860	133	142	147	149	144
1954	1,107.0	1,254.1	2,441.6	981.6	10,861	134	144	148	148	144
1955	1,122.5	1,295.7	2,501.2	1,012.6	11,145	135	148	152	153	148
1956	1,160.2	1,354.7	2,531.6	1,050.8	11,420	140	155	154	159	152
1957	1,198.6	1,407.5	2,634.1	1,064.0	11,753	145	161	160	161	156
1958	1,212.6	1,433.8	2,658.3	1,110.2	12,083	146	164	161	168	160
1959[c]										

a/ Depreciation and other capital consumption, seed, fertilizer, repairs and operation of capital items, miscellaneous.

b/ Total production expenses were not available by regions for 1947 and 1948. They were estimated for each region on the basis of the relationship for the United States in 1947, 1948, and 1949.

c/ Not available when this was written.

Source:

U. S. Agricultural Marketing Service, Production Expenses of Farm Operators, by States (Rev., Washington: Govt. Print. Off., 1959) (AMS-85)

APPENDIX TABLE 5

Index Numbers of Farm Output in Major Vegetable Producing Regions, 1947-1959

Year	North East	Lake States	Corn Belt	Pacific	United States
	1	2	3	4	5
	1947-49 = 100				
1947	98	95	85	98	95
1948	100	102	110	100	104
1949	102	103	105	102	101
1950	107	102	104	105	101
1951	108	108	104	112	104
1952	107	112	112	116	108
1953	110	112	109	118	109
1954	111	115	112	121	109
1955	110	118	117	121	113
1956	115	123	121	126	114
1957	109	121	119	129	114
1958	117	126	128	130	124
1959[a/]	114	129	135	137	126

a/ Preliminary.

Source:

U. S. Agricultural Research Service, Changes in Farm Production and Efficiency, A Summary Report (Rev., Washington: Govt. Print. Off., July, 1960) (U.S.D.A. Stat. Bul. No. 233).

APPENDIX TABLE 6

Series Used in Computing Indexes of Factor Prices, Unit Costs, and Productivity in Vegetable Processing

Year	Employment of production workers in the Canning and Preserving industries				Federal Reserve Board indexes of output		Capital and overhead charges in the Food and Kindred Products industries[a]	
	average total	average weekly	average weekly total man-hours		canned and frozen foods	food manufacturing		
	1	2	3	4	5	6	7	8
	workers (1000's)	hours per worker	(1000's)	index 1947-49=100	1947-49=100		million dollars	index 1947-49=100
1947	211	39.7	8,377	104	98	100	851	93
1948	210	38.2	8,022	100	100	99	914	99
1949	198	38.8	7,682	96	102	101	990	108
1950	197	39.3	7,742	97	110	104	1,059	115
1951	204	40.0	8,160	102	120	106	1,177	128
1952	198	39.3	7,781	97	120	110	1,218	133
1953	207	39.1	8,094	101	126	111	1,251	136
1954	195	38.7	7,547	94	130	114	1,319	144
1955	196	38.7	7,585	95	135	119	1,426	155
1956	202	39.5	7,979	99	152	123	1,480	161
1957	188	39.0	7,332	91	142	123	1,568	171
1958	187	39.6	7,405	92	149	125	1,680[b]	183[b]
1959	189	39.1	7,390	92	156	131	1,737[b]	189[b]

a/ Includes rent paid on business property, repairs that do not add materially to property value or appreciably prolong life, interest paid, depreciation and depletion, and taxes, excluding income and excess profits tax, estate, inheritance, legacy and gift taxes, taxes assessed against local benefits, and taxes reported on "cost of goods sold" or "cost of operation."

b/ Corporate income statistics were not available for these years. Changes in the value of capital and overhead charges were estimated to be proportional to changes in the reported gross value of property, plant, and equipment in the Food and Kindred Products industries, as reported in Federal Trade Commission, Quarterly Financial Report for Manufacturing Corporations (Washington, D.C., quarterly). Relative changes in the two series were similar in the few years prior to 1958.

(Continued on next page.)

APPENDIX TABLE 6 (continued)

Source:

Employment of Production Workers:

U. S. Bureau of Labor Statistics, Monthly Labor Review (Washington, D. C., monthly).

Indexes of Output:

Board of Governors of the Federal Reserve System, Federal Reserve Bulletin (Washington, D. C., monthly).

Capital and Overhead Charges:

U. S. Treasury Department, Internal Revenue Service, Statistics of Income (Washington, D. C., annual issues).

APPENDIX TABLE 7

Relative Changes in Output per Man-Hour in Producing and Processing Vegetables, by United States Regions, 1947-1959

Year	Farm production a/					Processing b/
	North East	Lake States	Corn Belt	Pacific	United States	United States
	1	2	3	4	5	6
	1947-49 = 100					
1947	96	90	91	94	94	94
1948	104	102	108	102	104	99
1949	100	108	101	104	102	107
1950	106	108	111	108	107	114
1951	106	116	110	108	112	118
1952	110	118	107	114	117	124
1953	118	123	115	124	122	125
1954	119	128	120	132	126	139
1955	134	139	132	139	136	142
1956	146	157	141	145	149	153
1957	149	148	148	157	155	155
1958	157	177	159	160	161	162
1959 c/	156	190	173	169	172	170

a/ Includes the following: Potatoes, sweet potatoes, dry edible beans, dry field peas, truck crops for processing, and truck crops for fresh market.

b/ Output per production worker man-hour in the Canning and Preserving industries. Computed by dividing the Federal Reserve Board index of output in the Canned and Frozen Foods industries by the Bureau of Labor Statistics (index of) total average weekly hours of production workers in the Canning and Preserving industries. In 1959 the Federal Reserve Board made substantial upward revisions in its output indexes. These figures are therefore somewhat higher than the similar computations shown by Imogene Bright, "Trends in Labor Input and Output in Selected Agricultural Processing Industries, 1947-57," Agricultural Economics Research, October, 1959.

c/ Preliminary.

Source:

Farm Production:

U. S. Agricultural Research Service, Changes in Farm Production and Efficiency, Summary and Supplement III (Rev., Washington: Govt. Print. Off., July, 1960) (U.S.D.A. Stat. Bul. No. 233).

Processing:

See Appendix Table 6 and Footnote b/ above.

APPENDIX TABLE 8

Relative Changes in Vegetable Yields, by United States Regions, 1947-1959[a/]

Year	North East[b/]			Corn Belt and Lake States[c/]			Pacific			United States		
	fresh market	processing	total	fresh market	processing	total	fresh market	processing	total	fresh market	processing	total
	1	2	3	4	5	6	7	8	9	10	11	12
	1947-49 = 100											
1947	91	104	95	91	81	84	96	105	98	95	95	103
1948	107	99	104	112	114	114	97	96	98	103	104	99
1949	103	97	101	97	105	103	107	99	104	102	101	98
1950	106	118	110	99	98	105	99	97	99	100	104	99
1951	107	118	111	94	107	106	107	138	118	104	124	107
1952	105	103	105	86	110	106	109	137	119	103	118	105
1953	111	111	112	88	113	109	115	124	118	106	117	106
1954	108	94	104	88	114	111	116	114	115	104	109	104
1955	116	86	108	92	111	110	118	135	124	113	117	112
1956	121	125	123	99	136	128	120	158	134	118	149	125
1957	109	99	108	92	118	114	117	136	123	113	125	114
1958	113	130	120	93	128	124	119	160	134	116	148	124
1959	110	109	111	92	148	137	124	141	129	118	142	124

a/ Based on averages computed by dividing regional total tonnage of principal vegetables by regional harvested acres.

b/ Based on yields in Middle and South Atlantic states: New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida.

c/ Based on yields in the North Central states: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, Kansas.

Source:

Computed from U. S. Agricultural Marketing Service, Vegetables for Processing and Vegetables for Fresh Market (Washington, D. C.: Annual Summaries).

APPENDIX TABLE 9.

Changes in Output Relative to Quantities of "Other Production Inputs" in Farming and "Capital and Overhead Inputs" in Vegetable Processing, by United States Regions, 1947-1959

Year	Other production inputs--farming[a/] [b/]					Capital and overhead inputs--processing[c/]
	North East	Lake States	Corn Belt	Pacific	United States	United States
	1	2	3	4	5	6
	1947-49 = 100					
1947	102	99	89	102	99	100
1948	100	102	110	100	104	100
1949	98	99	101	98	97	100
1950	100	92	94	96	92	98
1951	97	93	88	94	89	99
1952	96	96	92	96	91	100
1953	95	91	85	91	87	100
1954	94	91	86	93	86	99
1955	93	92	88	91	88	98
1956	96	93	92	93	88	105
1957	92	92	91	98	89	105
1958	99	95	98	96	96	103
1959[d/]						106

a/ Includes seed, fertilizer, repairs and operation of capital items and depreciation and other capital consumption (labor and land are excluded).

b/ The indexes were computed by dividing the index of prices paid for "other production inputs" (Table 1) by the indexes of cost per unit of output (Table 3)--see Appendix A for more detailed explanation.

c/ Federal Reserve Board index of output in Food Manufacturing divided by an index of capital and overhead charges in the Food and Kindred Products industries (Appendix Table 6), deflated by the index of prices for capital and overhead inputs (Table 2).

d/ Data for farm production were not available when this was written.